1. GENERAL INTRODUCTION.

(a) Origin and Distribution.

The sunflower (Helinathus annuus) is generally recognised as being a native of North America, although it is found in South America especially along the west coast from Columbia to Chili. It is grown to a limited extent in Australia, New Zealand, South Africa, the Mediterranean Regions of Europe, India and China (11). The highest development and greatest usefulness has been reached in Russia where several important varieties have been developed (7).

(b) Uses of the Sunflower.

In Europe it is grown extensively for its seed and the oil which can be extracted from the seed, both being consumed as food. The stalks are commonly utilised as fuel by the peasants (10). In America the sunflower is principally grown as an important silage crop in districts where successful corn growing is uncertain due to the incidence of drought (6).

(c) Varieties of the Sunflower.

Helianthus annuus is divided into three subspecies consisting of the wild, the ornamental and the cultivated, each in turn being subdivided into a number of types. The subspecies represented by the ornamental form lies intermediate between the wild form with its large number of relatively small bracts, inflorescences and seeds and the cultivated form which is characterised by a much greater size and smaller number of all these organs. The ornamental form therefore represents a stage in the evolution of the cultivated form from the wild types (9). Even with the use of cultivated and ornamental forms alone, if these are subjected to inbreeding, hybridization and selection, there are great possibilities of evolving types for a specific purpose under a definite set of environmental conditions.

(d) Selection and Inbreeding within Self-fertilised Lines.

The sunflower is naturally cross-pollinated, and any attempted improvement by inbreeding entails artificial selfing or

the prohibition of cross pollination. Dealing with the question of the application of inbreeding to sunflower improvement, the last decade has introduced new prospects for the work of selection in cross-pollinated plants founded on the principles of inbreeding. Only too frequently the failure or partial failure of self-fertilisation led to the conclusion that inbreeding was injurious. The revolutionary work of Shull and East (5) with maize in America, of Heribert Nilsson with rye and Hjalmar Nilsson with sugar beet in Sweden all went to show that self-pollination in the allogamous plants may have, as a result, the production of all sorts of abnormalities, including reduced fertility and complete sterility. At the same time these workers have obtained healthy fertile progeny by inbreeding from suitable foundation stock.

The bulk of the work of inbreeding in the sunflower has been carried out since 1918 in the selection station of the Saratov Experimental Station. The work of Platschek showed that the sunflower, which in the past has been described as being self-sterile (8), might produce fertile progeny by self-pollination within a single head. It was also shown that sunflowers varied exceedingly in fertility. This has been substantiated by a recent private communication from Rose, who is working on the question of inbreeding in Rhodesia. The Russians showed that this fertility might be very low with only a few seeds in a head whereas it might show all degrees up to a high fertility (1000 seeds/head). In some reported cases self-fertilisation leads to complete sterility (1). The following fertility groups and subgroups were established by Platschek (8) as characteristic when inbreeding the sunflower:-

1. Sterile Group.
2. Weakly fertile group, not more than 100 seeds/head.
3. Fertile Group (a) 101-250 seeds per head.
   (b) 251-550 " " "
   (c) 551-1000 " " "
   (d) 1000 - and more per head.

The Russian workers have also shown that fertility in the sunflower is inherited and with repeated self-fertilisation the fertility tends

to rise within the fertile groups and fall in the weakly fertile groups. This is a very valuable characteristic when selecting the most desirable types.

The possibilities of the production of homozygous forms with the desired qualities makes inbreeding of special value for the allogamous plant such as the sunflower. The disclosure of recessives in pure form makes this method even more valuable and allows the elimination of the undesirable recessives from among the progeny of the selfed plants.

In conclusion it can be stated that the weaknesses of inbreeding are manifested by the production of deformities, albinos, sterility and diminished fertility but such plants because of their lack of vitality, diminished in proportion to the duration of the inbreeding. East and Nilsson suggest that the reduced fertility and yield which is generally observed as a result of inbreeding, is easily rectified by the crossing of permanently inbred progeny among themselves. This has been substantiated by Russian workers. Thus inbreeding far from being harmful to plants, affords a valuable means of eliminating undesirable recessive factors and establishing vigorous healthy lines. This is the principal method used in the present investigation, which aims at producing a type of sunflower which will make a useful green manuring crop in the tropics.

(e) Mass Selection.

Mass selection is easily the oldest method of selection practised in field crops. In reality it is an attempt by man to accelerate natural selection beyond the speed at which it would take place under ordinary conditions. The technique is simply the conservation of seed from the best heads grown on the particular type of plant which possesses the majority of the characters desired by the breeder. Such a procedure persevered in over a number of successive crops tends to increase the proportion of the desirable to the undesirable types, and if persisted in long enough should ultimately lead to a practically pure seed supply of a standardised type. Mass selection forms the subsidiary method used in the present investigation on the production of a green manuring type of sunflower.